PATENT SPECIFICATION

718,625

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Date of filing Complete Specification: *Feb. 10, 1953.*

Application Date: *Feb. 11, 1952.* *No. 3535/52.*

Complete Specification Published: *Nov. 17, 1954.*

DIV. 7

Index at Acceptance:—**Classes 82(1)**, A1C, A8A(2 : 3), A8(J : M : Q : R : U) : **and 99(1)**, G2(A : F : H).

COMPLETE SPECIFICATION.

Improvements in Flanged and Bolted Pipe Joints.

We, BABCOCK & WILCOX LIMITED, a British Company, of Babcock House, Farringdon Street, London, E.C.4, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to flanged and bolted joints for connecting together elements adapted to work at high temperatures and particularly to pipe joints or the like joints, for example, joints for connecting together pipes and valves or pipes and pressure vessels or pressure vessels and cover plates closing openings therein. Frequently such joints are required to remain fluid tight when the connected elements operate under high internal fluid pressure. In order to obtain the requisite strength in the bolts and avoid excessive creep at the temperatures involved, the use of metal for the bolts different from that of the flanges is frequently expedient. The materials of the bolts and flanges then possess different coefficients of thermal expansion and as a result leakage is liable to arise. An object of the invention is to lessen or obviate this danger.

The present invention includes a flanged and bolted pipe or the like joint for connecting elements adapted to work at high temperature and utilising bolts of material having a coefficient of thermal expansion different from that of a flange or flanges of the joint, wherein acting between each bolt near an end or each end thereof and the neighbouring flange are compensating means having a coefficient of thermal expansion different from that of the bolt and adapted to lessen or eliminate variation with temperature, due to differential expansion or contraction of the flange or flanges and the bolt, of tension on the bolt.

The invention also includes a flanged and bolted pipe or the like joint for connecting elements adapted to work under pressure and at high temperature and utilising bolts and flanges with coefficients of thermal expansion such that temperature rise tends to lessen the tension of the bolts, wherein acting between each bolt near an end or each end thereof and the neighbouring flange are compensating means having a coefficient of expansion greater than that of the bolt and adapted to maintain tension on the bolt, as temperature changes, substantially constant.

The invention will now be described, by way of example, with reference to the accompanying drawing which represents a fragmentary longitudinal section through a flanged and bolted joint provided between a valve body and a pipe and arranged in a steam line operating, for example, at a pressure of 1500 pound per square inch and a temperature of 1050° F. The section is taken through adjacent co-axial bolt holes formed in the flanges and one of the clamping nuts engaging the bolt is shown only partly in section.

The drawing shows a pipe 1 and a valve body 2 which are formed on the same ferritic steel. A flange 3 formed on the pipe abuts a similar flange 4 formed on the valve body. The face 5 of the flange 3 is formed near the interior of the pipe with an annular projection 6 which fits within a corresponding recess 7 provided in the face 8 of the flange 4 and containing a suitable steel and asbestos gasket 7^1. Outwardly of the annular projection 6 the face 5 is formed with an annular recess 9 which extends to within a short distance of the outer edge of the face.

In the neighbourhood of the flanges 3 and 4 the walls respectively of the pipe and the

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valve body are suitably thickened. The flange 3 is formed with an appropriate number of symmetrically disposed bolt holes 10 and corresponding bolt holes 11, arranged co-axially with the holes 10, are provided in the flange 4.

The outer end of each bolt hole is counter-bored to form an axially extending socket 12. A shoulder 15 at the inner end of each socket 12 provides a seating for engagement by the inner end of a ferrule 16 referred to below.

Through each pair of corresponding bolt holes 10 and 11 extends a bolt 17 including end parts 18 of reduced diameter and threaded parts 19 extending inwardly from the parts 18. Clamping nuts 20 having a coefficient of thermal expansion which is the same or substantially the same as that of the bolts, each comprise a main cylindrical part 21 formed with an internal thread adapted to engage one of the threaded parts 19 of the bolt and an outer hexagonally-shaped part 22 including a bore 23 through which extends one of the end parts 18 of the bolt so that expansion of the bolt may be readily observed. At one end of each bolt 17, a part 24 of square form is provided outside the adjacent nut 20 to enable the bolt to be held against turning.

Surrounding the bolt and disposed mainly within each socket 12 is one of the ferrules 16 which extends between the shoulder 15 and a surface 25 of the adjacent nut 20. It will be appreciated that each ferrule 16 could alternatively be wholly disposed in one of the sockets 12 in which case the length of each ferrule would be equal to the axial length of its corresponding socket. The ferrules act as compensating means for differential expansion between the bolt 17 and the flanges 3 and 4 and have a coefficient of thermal expansion which is greater than that of the bolt. As the clamping nuts and the bolt have the same or substantially the same coefficient of thermal expansion, the effective length of the bolt, for the purpose of considering differential expansion between the bolt and the flanges may be taken as the length between the surfaces 25. Similarly, the effective length of the flanges may be taken as the length between the shoulders 15.

During operation, as the pipe 1 and valve body 2 are heated up, the flanges 3 and 4 expand outwardly respectively from the flange faces 5 and 8 and each bolt 17 likewise expands outwardly but at a greater rate. The ferrules 16, however, expand inwardly from the surfaces 25 at a still greater rate. The inward expansion of the ferrules may, furthermore, be equal to the difference between the expansion of the effective length of the bolt 17 and the expansion of the effective length of the flanges 3 and 4 and under these circumstances the tension on the bolt remains substantially unaltered.

In a preferred form of the joint, the pipe 1 and the valve body 2 are formed of the same ferritic steel, namely, $2\frac{1}{4}$% chromium, 1% molybdenum steel which possesses a coefficient of thermal expansion of 7.8×10^{-6} per 1° F. Each of the flanges 3 and 4 has an axial length of $5\frac{1}{4}''$ and the axial length of each socket 12 is $2\frac{3}{8}''$, so that the effective length of the flanges, that is the length between the shoulders 15, is equal to $5\frac{3}{4}''$. The bolts 17 are formed of an alloy comprising 17% chromium, 17% nickel, 3% manganese, 2.5% molybdenum, 7% cobalt and 1.8% columbium and having a coefficient of thermal expansion of 8.9×10^{-6} per 1° F. The effective length of the bolt, that is the length between the surfaces 25, is equal to $11\frac{1}{2}''$. The nuts 20 are made of material of similar composition to that of the bolts and have the same coefficient of expansion as the bolts. The ferrules are made of austenitic steel comprising 18% chromium, 12% nickel and 1% columbium and having a coefficient of thermal expansion of 10×10^{-6} per 1° F. With these dimensions, it will be seen that for a given change of temperature the expansion of the ferrules is exactly equal to the difference between the expansion of the effective length of the bolt 17 and the expansion of the effective length of the flanges 3 and 4 with the result that the tension on the bolt remains substantially unaltered.

In some instances it may be convenient or necessary to provide the compensating means at one end only of a bolt, for example, when the bolt is a stud bolt.

What we claim is :—

1. A flanged and bolted pipe or the like joint for connecting elements adapted to work at high temperature and utilising bolts of material having a coefficient of thermal expansion different from that of a flange or flanges of the joint, wherein acting between each bolt near an end or each end thereof and the neighbouring flange are compensating means having a coefficient of thermal expansion different from that of the bolt and adapted to lessen or eliminate variation with temperature, due to differential expansion or contraction of the flange or flanges and the bolt, of tension on the bolt.

2. A flanged and bolted pipe or the like joint for connecting elements adapted to work under pressure and at high temperature and utilising bolts and flanges with coefficients of thermal expansion such that temperature rise tends to lessen the tension of the bolts, wherein acting between each bolt near an end or each end thereof and the neighbouring flange are compensating means having a coefficient of expansion greater than that of the bolt and adapted to maintain tension on the bolt, as temperature changes, substantially constant.

3. A joint as claimed in Claim 1 or Claim

2, wherein the compensating means comprise a ferrule disposed around the bolt between the neighbouring flange and a clamping nut.

4. A joint as claimed in Claim 3, wherein the ferrule is housed at least partly within a socket in the flange.

5. A joint as claimed in Claim 2, arranged and adapted to operate substantially as hereinbefore described with reference to the accompanying drawing.

For the Applicants,
A. C. PRICE,
Chartered Patent Agent.

PROVISIONAL SPECIFICATION.

Improvements in Flanged and Bolted Pipe Joints.

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This invention relates to flanged and bolted joints for connecting together elements adapted to work at high temperatures and particularly to pipe joints or the like joints, for example, joints for connecting together pipes and valves or pipes and pressure vessels or pressure vessels and cover plates closing openings therein. Frequently such joints are required to remain fluid tight when the connected elements operate under high internal fluid pressure. In order to obtain the requisite strength in the bolts and avoid excessive creep at the temperatures involved, the use of metal for the bolts different from that of the flanges is frequently expedient. The materials of the bolts and flanges then possess different coefficients of thermal expansion and as a result leakage is liable to arise. An object of the invention is to lessen or obviate this danger.

The present invention includes a flanged and bolted pipe or the like joint for connecting elements adapted to work at high temperature and utilising bolts of material having a coefficient of thermal expansion different from that of a flange or flanges of the joint, wherein acting between each bolt at an end or each end thereof and the neighbouring flange are compensating means having a coefficient of thermal expansion different from that of the bolt and adapted at least to lessen variation with temperature, due to differential expansion or contraction of the flange or flanges and the bolt, of tension on the bolt.

The invention also includes a flanged and bolted pipe or the like joint for connecting elements adapted to work under pressure and at high temperature and utilising bolts and flanges with coefficients of thermal expansion such that temperature rise tends to lessen the tension of the bolts, wherein acting between each bolt at an end or each end thereof and the neighbouring flange are compensating means having a coefficient of expansion greater than that of the bolt and adapted to maintain tension on the bolt, as temperature changes, substantially constant.

In one particular embodiment of the invention as applied to a steam line working at a pressure of about 1500 pounds per square inch and a temperature of about 1,050° F., a flanged and bolted joint is provided between a valve body and a pipe both formed of ferritic steel, being a $2\frac{1}{4}$% chromium molybdenum steel. Each flange has an axial dimension of $5\frac{1}{4}$ inches and the face of the pipe flange is formed a short distance from the interior of the pipe with an annular projection for entering a corresponding recess provided in the face of the flange on the valve body and containing a suitable steel and asbestos gasket. The face of the pipe flange is also formed outwardly of the annular projection with an annular recess extending within a short distance from the outer edge of the face. The walls of the valve body and pipe in the neighbourhood of the flanges are suitably thickened and the flanges are formed with a suitable number of symmetrically disposed bolt holes.

The outer end of each bolt hole is counterbored to form a recess of larger diameter having a length of $1\frac{3}{4}$ inches, the shoulders at the inner ends of the recesses constituting seatings for engagement by the inner ends of ferrules referred to below.

The ferritic steel of the valve body and pipe possesses a coefficient of thermal expansion of 7.8×10^{-6} per 1° F., whilst the bolts are formed of an alloy comprising 16.5% chromium, 17.5% nickel, 3.0% molybdenum, 7.0% cobalt and 2.5% columbium and having a coefficient of thermal expansion of 8.9×10^{-6}.

Parts of each bolt near the ends are threaded for the reception of clamping nuts having main inner cylindrical parts of larger diameter and outer parts of hexagonal shape. The extremities of the bolt are of reduced diameter and extend through bores in the hexagonal parts of the nuts so that elongation of the bolts may be observed. At one end a part of the bolt outside the adjacent nut is of square form to enable the bolt to be held against turning.

Disposed mainly within each flange recess,

surrounding the bolt and acting between the adjacent nut and the flange is a ferrule having a length of $2\frac{1}{4}$ inches. The ferrules and nuts are of austenitic steel comprising 18% chromium and 8% nickel and having a coefficient of thermal expansion of 10×10^{-6}. The length of the portion of the threaded end part of the bolt which extends into each nut has a length of substantially $2\frac{1}{2}$ inches and taking into account the slackness between the threaded ends of the bolt and the nuts it is assumed that there is an anchor point between the bolt and each nut at the mid-point of that portion of the threaded end part of the bolt which extends within the nut. For the purpose of considering differential expansion between the bolt and the flanges, the bolt therefore possesses an effective length of 14 inches.

During operation, as the valve body and pipe are heated up, the flanges expand outwardly from the flange faces and each bolt likewise expands outwardly but at a greater rate. The nuts and ferrules, however, expand at a still greater rate. Moreover, the expansion is inwardly from the anchor points between the nuts and the bolt, whilst the total inward expansion of the nuts and ferrules is equal to the difference between the expansion of the bolt and the expansion of the flanges. As a result the tension of the bolt remains substantially unaltered.

In some instances it may be convenient or necessary to provide the compensating means at one end only of a bolt, for example, when the bolt is a stud bolt.

For the Applicants,
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Abingdon : Printed for Her Majesty's Stationery Office, by Burgess & Son (Abingdon), Ltd.—1954.
Published at The Patent Office, 25, Southampton Buildings, London, W.C.2,
from which copies may be obtained.

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285-187 AU 351 45411 TAIN

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GB 0718625
NOV 1954

718,625 COMPLETE SPECIFICATION
1 SHEET

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